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Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. | Patent application No. | Demande de brevet n°

00480018.1

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
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THE HAGUE, 28/03/00
LA HAYE, LE

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Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

Anmeldung Nr.:
Application no.:
Demande n°: 00480018.1

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Anmelder:
Applicant(s):
Demandeur(s):
INTERNATIONAL BUSINESS MACHINES CORPORATION
Armonk, NY 10504
UNITED STATES OF AMERICA

Bezeichnung der Erfindung:
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Titre de l'invention:
Method of injecting/extracting control cells in an asynchronous transfer mode (ATM) network

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

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Method of injecting/extracting control cells in an Asynchronous Transfer Mode (ATM) network

Technical field

The invention relates generally to the Asynchronous Transfer Mode (ATM) networks wherein a connection is established between a source ATM device and a destination ATM device by the intermediary of a plurality of network switching nodes, and relates in particular to a method of injecting control cells such as Operation And Maintenance (OAM) cells into the connection at an injection switching node and extracting such control cells out of the connection at an extraction switching node.

Background

The use of ATM switching nodes in an IP network has become the most attractive solution since ATM hardware switches have been extensively studied and are widely available in many different architectures.

When a connection is established in the ATM network from a source ATM device to a destination ATM device by the

intermediary of a plurality of switching nodes, the incoming cells to a switching node are automatically routed to the next switching node of the connection. For this, each cell is composed of an ATM header and of a payload. The ATM protocol engine of the switching node identifies the incoming ATM cell using a lookup table. In the case of a valid cell (valid means belonging to an existing connection), the protocol engine performs traffic management function (traffic policing, congestion management, priority management) and queues the cell in an appropriate queue. A scheduler using priority based scheduling procedures selects queues from which cells are to be transmitted. Those cells are dequeued from their queue. Prior transmission, the protocol engine adds routing labels to the cell : the switch routing label (SRL) and the protocol engine correlator (PEC). The resulting internal cell format used within the switching node will be denominated hereafter labeled cell. The SRL contains either explicitly the destination blade or a pointer to a translation table located in the switching device and containing the explicit destination blade. The PEC is a pointer used by the protocol engine of the output adapter to identify the connection The protocol engine in the output destination adapter receives the cell from the switching device. Similarly to the input protocol engine, it identifies the incoming cell by performing a lookup function on the appended protocol engine correlator, runs traffic management functions, queues the cell in the appropriate queues, dequeues the cell under control of a scheduler, removes the appended labels, swaps the ATM label and transmits the cell on the connection destination ATM port(s).

When control cells such as Operation And Maintenance (OAM) cells are to be transmitted from an ATM switching node to another ATM switching node of the connection, the classical way is to transmit control messages between the two switching nodes using specific resources such a microprocessor dedicated

to such a task in each switching node. But such a solution is not appropriate and expensive inasmuch as it requires to incorporate microprocessors on the adapter cards of the switching nodes whereas the normal connection cells use ASIC modules which are data processing units specifically designed for the routing of the ATM cells.

Summary of the invention

Accordingly, the object of the invention is to achieve a process using the normal resources of the switching node in the transmission of the ATM cells, for transmitting control cells from an ATM switching node to another switching node of the network.

Another object of the invention is to achieve a process for injecting by the input control point of an ATM switching node control cells into a valid ATM connection.
Yet another object of the invention is to achieve a process for extracting to the output control point of an ATM switching node, control cells from a valid ATM connection.

Therefore, according to the first aspect, the invention relates to a method of injecting a control cell into a data connection setup between a source ATM device and a destination ATM device through switching nodes of an Asynchronous Transfert Mode (ATM) network, the control cell being injected into the connection by the control point of an injection switching node. The method consists in the steps of generating by the control point a control cell composed of a payload and an ATM header containing the input VP/VC of the connection in order to constitute an ATM cell, adding to the ATM cell a switch routing label (SRL) and a protocol engine correlator (PEC) in order to constitute a labeled cell, and adding an injection flag for indicating to the protocol engine of the

control point that such a flagged cell is a control cell to be injected into the connection.

According to the second aspect, the invention relates to a method of extracting a control cell from a data connection setup between a source ATM device and a destination ATM device through switching nodes of an Asynchronous Transfert Mode (ATM) network, the control cell being extracted towards by the control point of an extraction switching node. The method consists in determining by the protocol engine of the input adapter receiving an incoming cell in the extraction switching node, whether this incoming cell includes an extraction condition, putting a control flag in the control block of the incoming cell if it includes an extraction condition indicating that it is a control cell to be extracted, and adding to the control cell a switch routing label corresponding to the control point (CP SRL) and a reserved static protocol engine correlator (SPEC) in order to constitute a labeled cell before it is transmitted to the switch of the extraction switching node.

Brief description of the drawings

The above and other objects, features and advantages of the invention will be better understood by reading the following more particular description of the invention in conjunction with the accompanying drawings wherein :

- Fig. 1 represents a block-diagram of an ATM network including four switching nodes illustrated schematically by a control point blade and several adapter blades.
- Fig. 2 represents a schematic block-diagram of a switching node with the control point blade and an adapter blade connected to the switch.
- Fig. 3 is a schematic representation of an ATM network including a switching node where a cell injection is

performed and a switching node where a cell extraction is performed.

- Fig. 4 is a block-diagram representing schematically the injection of a control cell by the control point of the injection switching node.
- Fig. 5A and 5B are block-diagrams representing schematically the extraction of an OAM control cell by the control point of the extraction switching node.
- Fig 6 is a flow chart representing the sequential steps of the process implemented for the extraction of a control cell.

Detailed description of the invention

Fig. 1 shows an example of an ATM network 10 implementing the system according to the invention, and comprising four switching nodes 12, 14, 16 and 18 being respectively connected to local consoles 20, 22, 24 and 26. Each switching node is composed of a Control Point (CP) blade such as CP blades 28 of switching node 12, a plurality of adapter blades such as adapter blade 30 in node 10, which provide the physical attachments to network devices such as the other switching nodes or the user workstations and a switch fabric providing cell switching between its ports on which are attached the adapter blades. The local console attached to the CP blade in each node is used for the network and control management.

It is assumed that a connection is established between a source ATM device attached to switching node 12 and a destination ATM device attached to switching node 18 through the intermediary switching nodes 14 and 16. According to the principles of the invention, control cells can be injected into this connection by control point 28 of node 12 and can be extracted by control point 29 of node 18, using the normal resources included in each of said nodes. It must be noted that the control cells could also be injected by a control point of any intermediary switching node such as node 14 and

could be extracted by any subsequent intermediary switching node such as node 16.

In each switching node, the internal structure of which is illustrated in Fig. 2, each adapter blade 30 and the CP blade 28 share the same flow structure. Two ASIC modules are used in each blade, the Common ATM Data mover (CAD) module 32 which basically handles the data flow, and the Common ATM Processor (CAP) module 34 which performs the necessary ATM processing. The module CAD is connected to switch 36.

Each module is split into two parts, an UP side for the receive flow and a DN side for the transmit flow.

- **UP** : The CAD UP receives data from the physical links and stores them in a data storage. For each cell received, a minimum information is exchanged with the CAP UP for the cell processing (VP, VC and cell buffer ID). The CAP UP sends back the information needed to forward the cell through the switch by the CAD UP. This information is found in the control storage of the CAP UP. Note that switch 36 connects blades UP to blades DOWN and forwards the cells from an input port to an output port.
- **DOWN** : The CAD DN receives data from switch 36 and stores them in a data storage. For each cell received, a minimum information is exchanged with the CAP DN for the cell processing (Protocol Engine Correlator (PEC) and cell buffer ID). The CAP DN sends back the information needed to forward the cell to the correct destination port and ATM connection by the CAD DN.

In the Control Point blade, there is the same structure as in an adapter blade, the control point being an ATM device of the ATM network.

The principles of the invention are illustrated in Fig. 3 showing a connection 40-40' setup from a first switching node called the injection node to a second switching node called the extraction node through network 10. The injection of the control cells into the connection is performed by the control point of the injection node and the extraction of the control cells is performed towards the control point of the extraction node.

When a control cell such as an OAM cell has to be injected in a defined connection of a switching node by the control point, the process is as illustrated schematically in Fig. 4. The defined connection is characterised in the switching node by the input port in the switching node, the input ATM label (VP-VC in), the output port in the switching node, the output ATM label (VP-VC out).

When a cell of the connection is received by the input blade, the input protocol engine identifies the incoming cell using the lookup table with the input port and the input ATM label. The lookup return are the traffic parameters and the routing parameters. The routing parameters comprise the Switch Routing Label (SRL) processed by the switch of the switching node to route the cell to the output blade and the PEC used by the output protocol engine of the output blade to identify the cell received from the switch.

To inject an OAM cell (or any type of other control cells such as Ressource Management (RM) cells well known to the person skilled in the art) on the connection, the control point 42 transmits a labeled cell characterized by the input VPI-VCI of the defined connection, the routing labels of the defined connection (SRL and PEC), the Payload Type Indicator (PTI) field of the ATM header defining the cell as an OAM cell (respectively RM cell), and a flag indicating the the cell is an injected cell

The input protocol engine in the control point blade bypasses the ATM label lookup 48 in view of the injection flag in the header of the labeled cell and the enqueue function into queues 50 and the dequeue function are performed. Then, the injection flag is again used to bypass the step of appending the routing labels and the cell is directly transferred to XMIT unit 52 for being transmitted to switch 44. Note that the injection flag is removed from the cell before the transmission to switch 44.

Therefore, when received by switch 44, the cell has exactly the same processing information as a regular cell of the connection that would have been received on the input port, except that this information (SRL, PEC) has been assigned by the control point of the injection node. After the switch 44, the data flow process used with the injected OAM cell is the same one as the data flow process used with a regular cell. As shown in Fig 4. the transmitted OAM cell includes the OAM payload and the swapped label (ATMH OAM) when it is transmitted from an output port over the network.

The extraction process of the OAM cell is now explained in reference to Fig. 5A and Fig. 5B. First, at switching node initialisation, the control point of the switching node defines static routes from any ports of the switching node towards the control point. It defines two static parameters in all input blades of the switching node : the SRL called hereafter CP_SRL which corresponds to the output blade to which the control point is attached (this parameter is common to all blades), and a blade identifier called hereafter B_id, which is, in the preferred embodiment of the invention, the encoded value of the blade (this parameter is specific to a blade). This identifier will be used by the protocol engine of an input blade in the extraction process to form a particular PEC denominated hereafter Static PEC (SPEC). The SPEC comprises the encoding of the input blade (B_id) and an

encoding of the input port in the input blade. For example, a possible encoding assuming that the switching node has 16 blades, that each blade has 4 ports and that PECs are 14 bits wide, can be used in the preferred embodiment. It is however obvious to the person skilled in the art that any alternate encoding may be chosen without changing the scope of the invention :

SPEC = b'00 0000 00PP BBBB' where BBBB = B_Id and PP = encode_port.

It then defines in the PEC table of the output blade to which the control point is attached, the entries corresponding to the SPECs used in the switching node. In the previous SPEC example, the control point has to define 64 entries in the PEC table corresponding to the 64 static routes from any of the 64 ports of the switching device towards the control point. Each of the SPEC entries contains the same information : the cell received with this PEC has been extracted. This information will be used as shown hereafter by the output protocol engine of the control point blade to modify its regular processing when handling an extracted cell. It is important to note that the SPECs can no more be used by ATM connections in the control point blade (they are dedicated and statically allocated to the extraction process).

When a cell is received from an input port in an input adapter of the extraction node, the protocol engine of the adapter determines if the cell has to be extracted. Various extraction conditions may be used, the simplest one being a per connection flag indicating that all received OAM cells of the connection have to be extracted. The protocol engine puts a control flag in the control block of the cell to be extracted and runs its regular process from MPX unit 46 to XMIT unit 52. But, instead of appending the regular labels found in the connection control blocks, the protocol engine appends the SRL corresponding to the switch output port to which the control

point is connected (CP_SRL) and appends a reserved Static Protocol Engine Correlator (SPEC) using the Blade identifier B_Id information to the extracted OAM cell. Indeed, contrary to the establishment of the normal connections which is dynamic process, the control point of the extraction node establishes static paths at the initialization time of the node. Thus, it defines in each input adapter a register which contains the SRL enabling to reach the control point (CP SRL) and a particular PEC identifying the input adapter which is therefore a Static Protocol Engine Correlator (SPEC). The cell which is transferred by XMIT unit 52 to switch 44 includes the CP SRL and the SPEC ahead of the OAM payload as illustrated in Fig. 5A.

Then, switch 44 routes the cell to the control point adapter as illustrated in Fig. 5B. The protocol engine performs the routing label (PEC) lookup function 54 whose return contains the an indication that the cell has been extracted towards the control point (this information is written by the control point in the entries of the lookup table corresponding to the reserved labels used to extract the cells). The protocol engine then flags the cell to be extracted (extraction flag). After queuing and dequeuing by means of queues 56, the flag is used to bypass the remove routing label/ATM label swap function directly to XMIT unit 58 so that the cell received by the control point 62 after DMPX unit 60 contains the incoming ATM label (input VP/VC) and the source and input adapter identifications encoded in the SPEC. This allows the control point 62 to identify the connection to which the received extracted cell belongs.

In reference to Fig. 6, the process for extracting a control cell in a switching node is as follows. When the cell has been identified (step 70) by the protocol engine of the input adapter (if not identified the cell is discarded), it is checked whether the cell has to be extracted as a control cell

or not (step 72). If not, the switch routing label (SRL) and the protocol engine correlator (PEC) of the connection to which the cell belongs are appended to the cell as for all normal cells (step 74). If the extraction condition exists, a special switch routing label to the control point of the switching node (CP SRL) and a reserved static protocol engine correlator (SPEC) are appended to the cell (step 76).

In any case, the cell is then routed by the switch of the switching node (step 78) and in the output blade, a PEC lookup is performed (step 80) whose result indicates wether the cell contains an extraction flag or not (step 82). If not, the cell is processed regularly : a label swap is performed (step 84) and the routing labels (SRL and PEC) are removed (step 86) prior to cell transmission (step 88). Otherwise, the cell is transmitted to the control point of the switching node (step 90) with its header including CP SRL and SPEC (encoding the source port and the source blade) which have not been removed as in a normal cell and are used by the control point to identify the connection from which the cell was extracted.

CLAIMS

1. Method of injecting a control cell into a data connection setup between a source ATM device and a destination ATM device through switching nodes of an Asynchronous Transfert Mode (ATM) network (10), said control cell being injected into said connection by the control point (42) of an injection switching node ; said method being characterized by the following steps :
- generating by said control point a control cell composed of a payload and an ATM header containing the input VP/VC of said connection in order to constitute an ATM cell,
- adding to said ATM cell a switch routing label (SRL) and a protocol engine correlator (PEC) in order to constitute a labeled cell, and
- adding an injection flag for indicating to the protocol engine of said control point that such a flagged cell is a control cell to be injected into said connection.

2. Method of injecting a control cell according to claim 1, wherein the protocol engine function of label lookup to identify the cell is bypassed in view of said injection flag.

3. Method of injecting a control cell according to claim 1 or 2, wherein the protocol engine function of appending the routing labels to a normal cell is bypassed in view of said injection flag.

4. Method of extracting a control cell from a data connection setup between a source ATM device and a destination ATM device through switching nodes of an Asynchronous Transfert Mode (ATM) network (10), said control cell being extracted by the control point (62) of

an extraction switching node ; said method being characterized by the following steps :

- determining by the protocol engine of the input adapter receiving an incoming cell in said extraction switching node, whether said incoming cell includes an extraction condition,
- putting a control flag in the control block of said incoming cell if said cell includes an extraction condition indicating that it is a control cell to be extracted, and
- adding to said control cell a switch routing label corresponding to said control point (CP SRL) and a reserved static protocol engine correlator (SPEC) in order to constitute a labeled cell before said labeled cell is transmitted to the switch (44) of said extraction switching node.

5. Method of extracting a control cell according to claim 4, wherein said CP SRL and SPEC are loaded into a register of said input adapter by said control point at the initialization time of said extraction switching node.

6. Method of extracting a control cell according to claim 5, wherein said SPEC is formed by the encoding of said input adapter (B_id) and the encoding of the the input port receiving said control cell in said input adapter.

7. Method of extracting a control cell according to claim 4, 5 or 6, wherein an extraction flag is added to said control cell by the protocol engine of said control point (62) when said protocol engine performs the routing label lookup (54).

8. Method of extracting a control cell according to claim 7, wherein the function of label swapping normally performed by the protocol engine of said control point (62) is

bypassed in view of said extraction flag, so that said control cell includes its input VP/VC and the source and input adapter identifications.

9. System of injecting control cells into a data connection in an Asynchronous Transfer Mode (ATM) network adapted for carrying out the method according to any one of claims 1, 2 or 3.

10. System of extracting control cells from a data connection in an Asynchronous Transfer Mode (ATM) network adapted for carrying out the method according to any one of claims 4 to 8.

Method of injecting/extracting control cells in an Asynchronous Transfer Mode (ATM) network

Abstract

Method of injecting/extracting a control cell into a data connection transmitted from a source switching node to a destination switching node of an Asynchronous Transfer Mode (ATM) network (10). The injecting method consists in adding to the ATM cell a switch routing label (SRL) and a protocol engine correlator (PEC) by the control point of the injection switching node before injecting the cell into the connection. The extracting method consists in putting a control flag in the control block of the incoming cell if this cell includes an extraction condition indicating that it is a control cell to be extracted, and adding to the control cell a switch routing label corresponding to the control point (CP SRL) and a reserved static protocol engine correlator (SPEC).

FIG. 3

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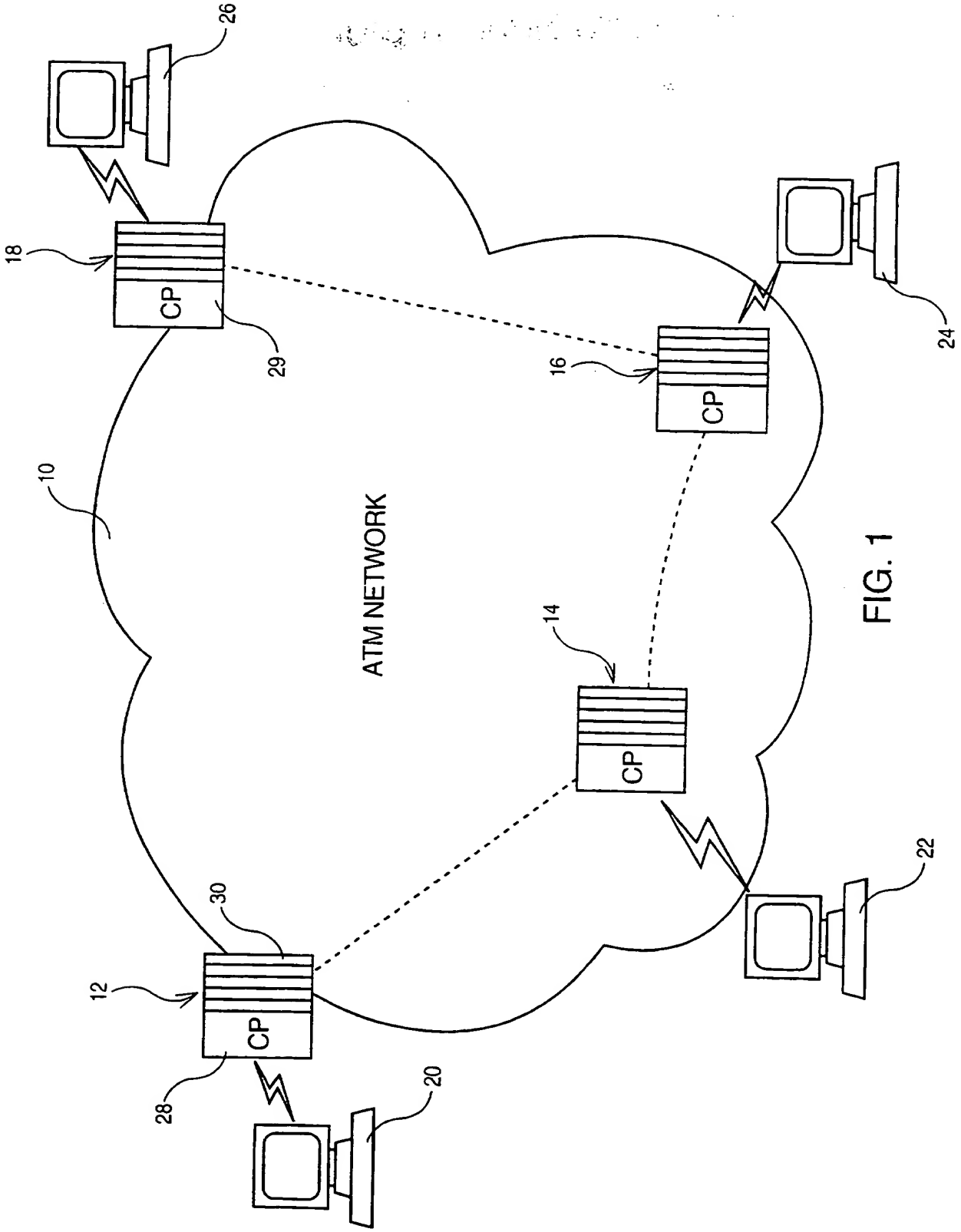

FIG. 1

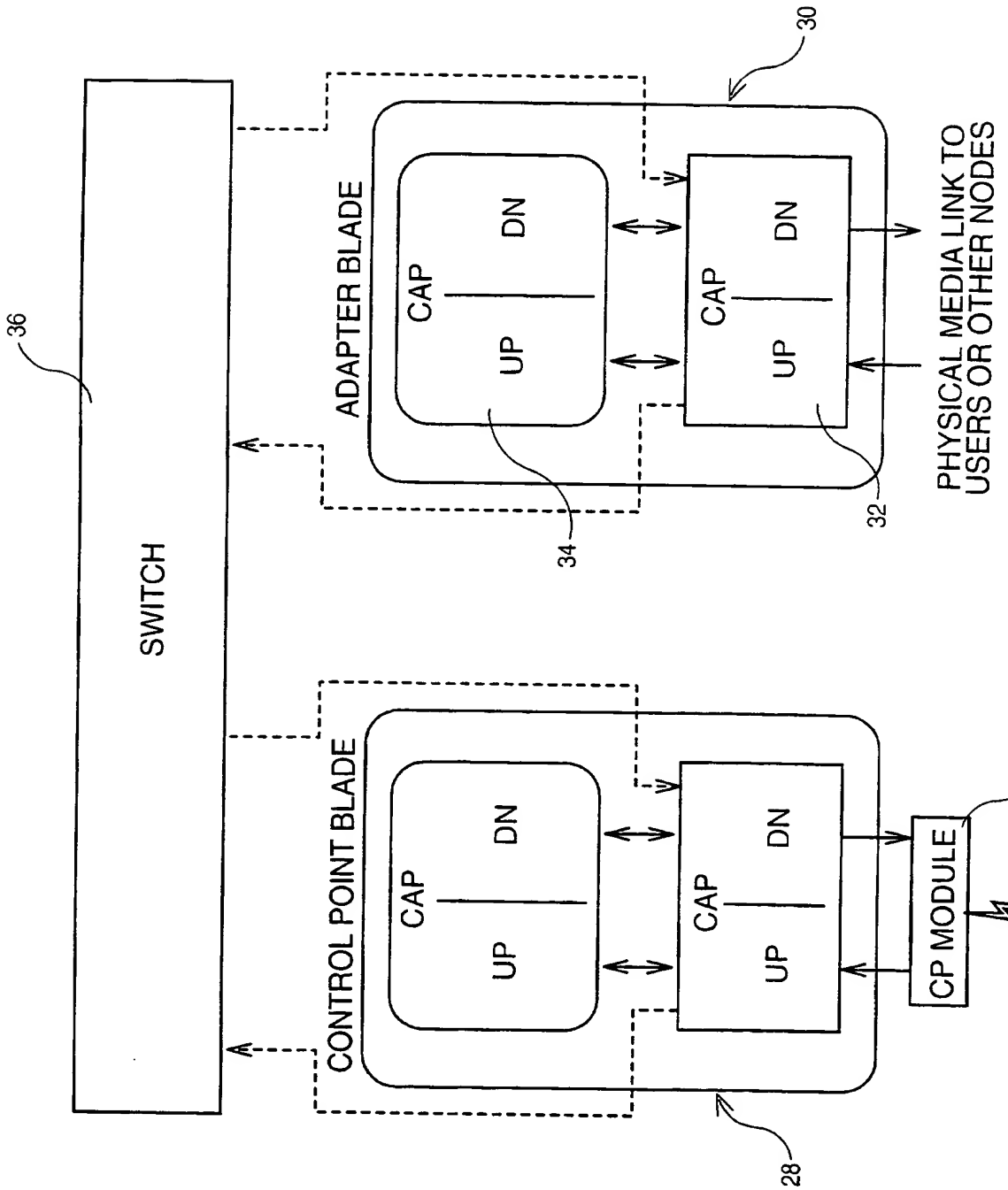
SWITCH
36
ADAPTER BLADE
30
CAP
DN
UP
CAP
DN
UP
34
32
PHYSICAL MEDIA LINK TO
USERS OR OTHER NODES
CONTROL POINT BLADE
CAP
DN
UP
CAP
DN
UP
CP MODULE
38
28

FIG. 2

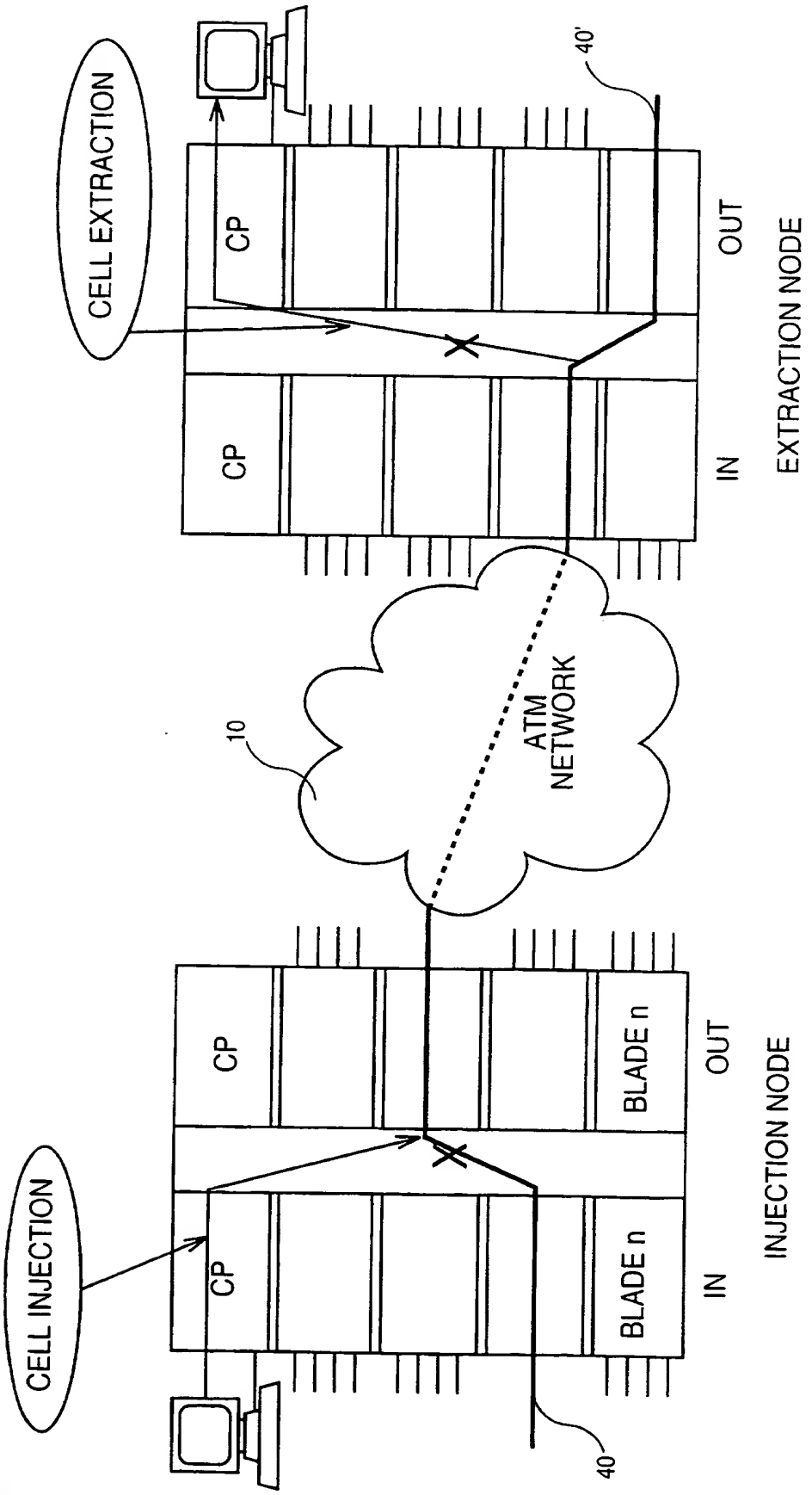
CELL EXTRACTION
CP
CP
40'
OUT
IN
EXTRACTION NODE
10
ATM
NETWORK
CELL INJECTION
CP
CP
BLADE n
BLADE n
OUT
IN
INJECTION NODE
40

FIG. 3

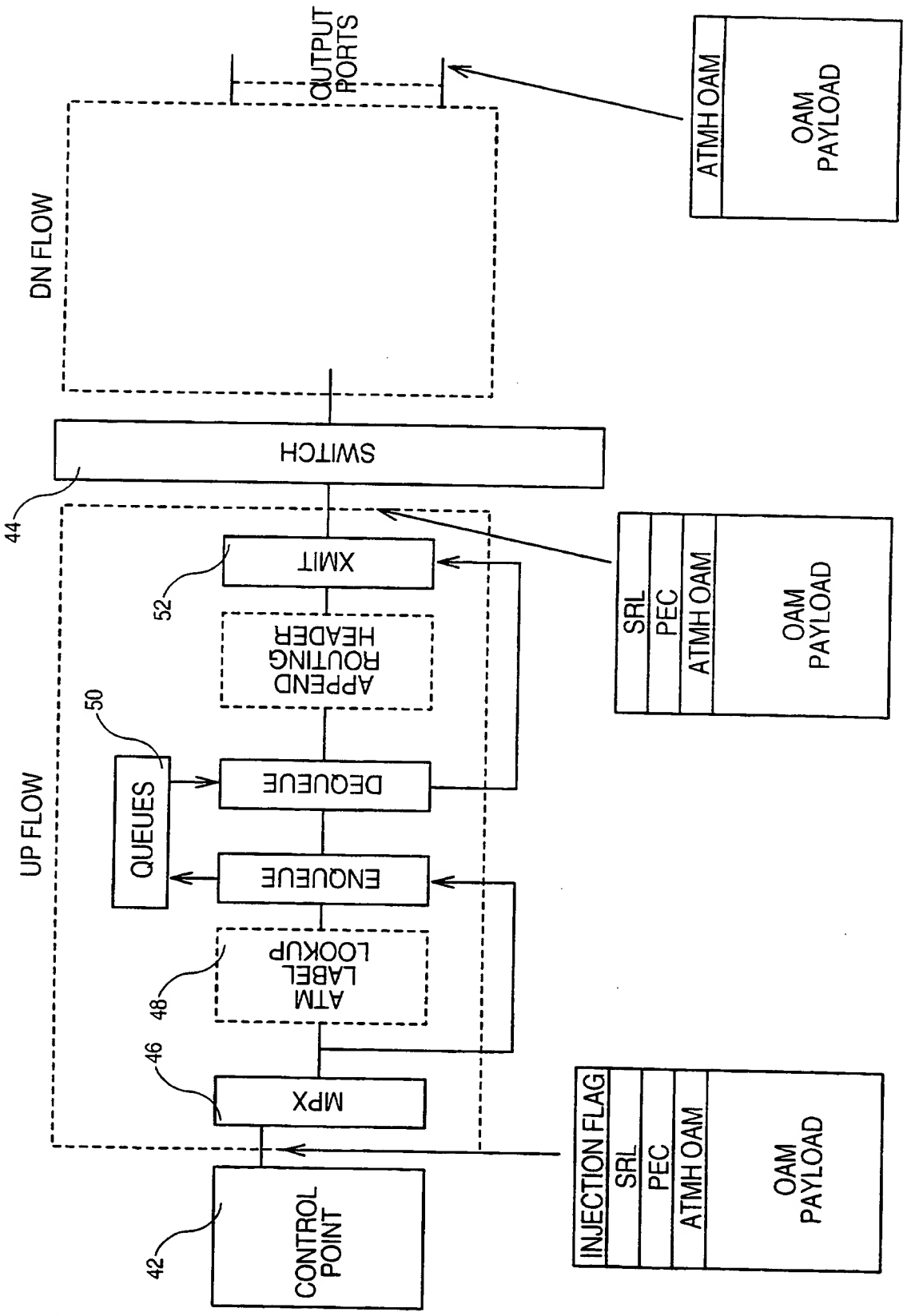
OUTPUT PORTS
ATMH OAM
OAM PAYLOAD
DN FLOW
SWITCH
44
XMIT
52
APPEND ROUTING HEADER
SRL
PEC
ATMH OAM
OAM PAYLOAD
50
QUEUES
DEQUEUE
ENQUEUE
UP FLOW
ATM LABEL LOOKUP
48
46
MPX
INJECTION FLAG
SRL
PEC
ATMH OAM
OAM PAYLOAD
CONTROL POINT
42

FIG. 4

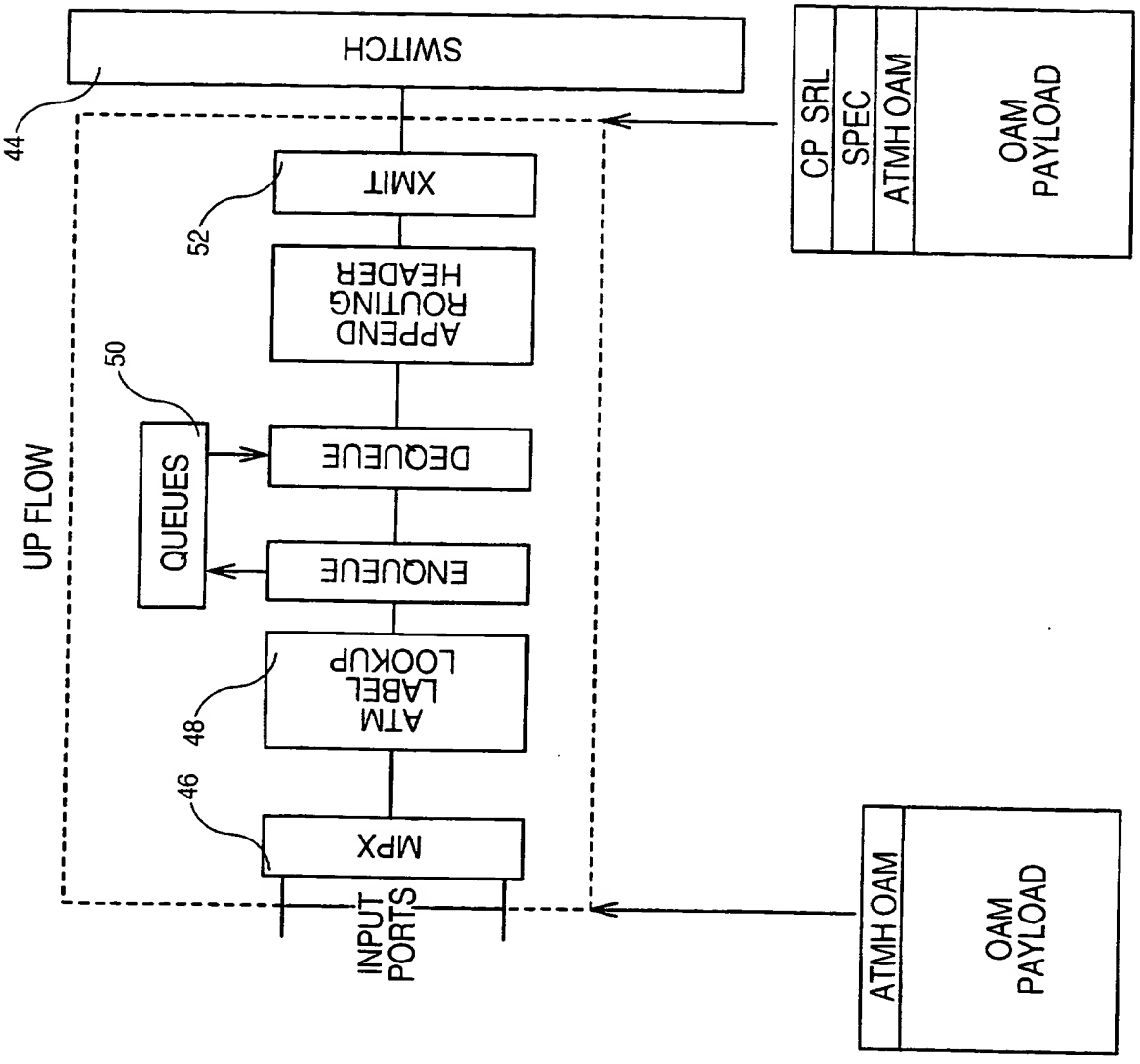
SWITCH
44
XMIT
52
APPEND ROUTING HEADER
50
QUEUES
DEQUEUE
ENQUEUE
ATM LABEL LOOKUP
48
46
MPX
INPUT PORTS
UP FLOW
CP SRL
SPEC
ATMH OAM
OAM PAYLOAD
ATMH OAM
OAM PAYLOAD

FIG. 5A

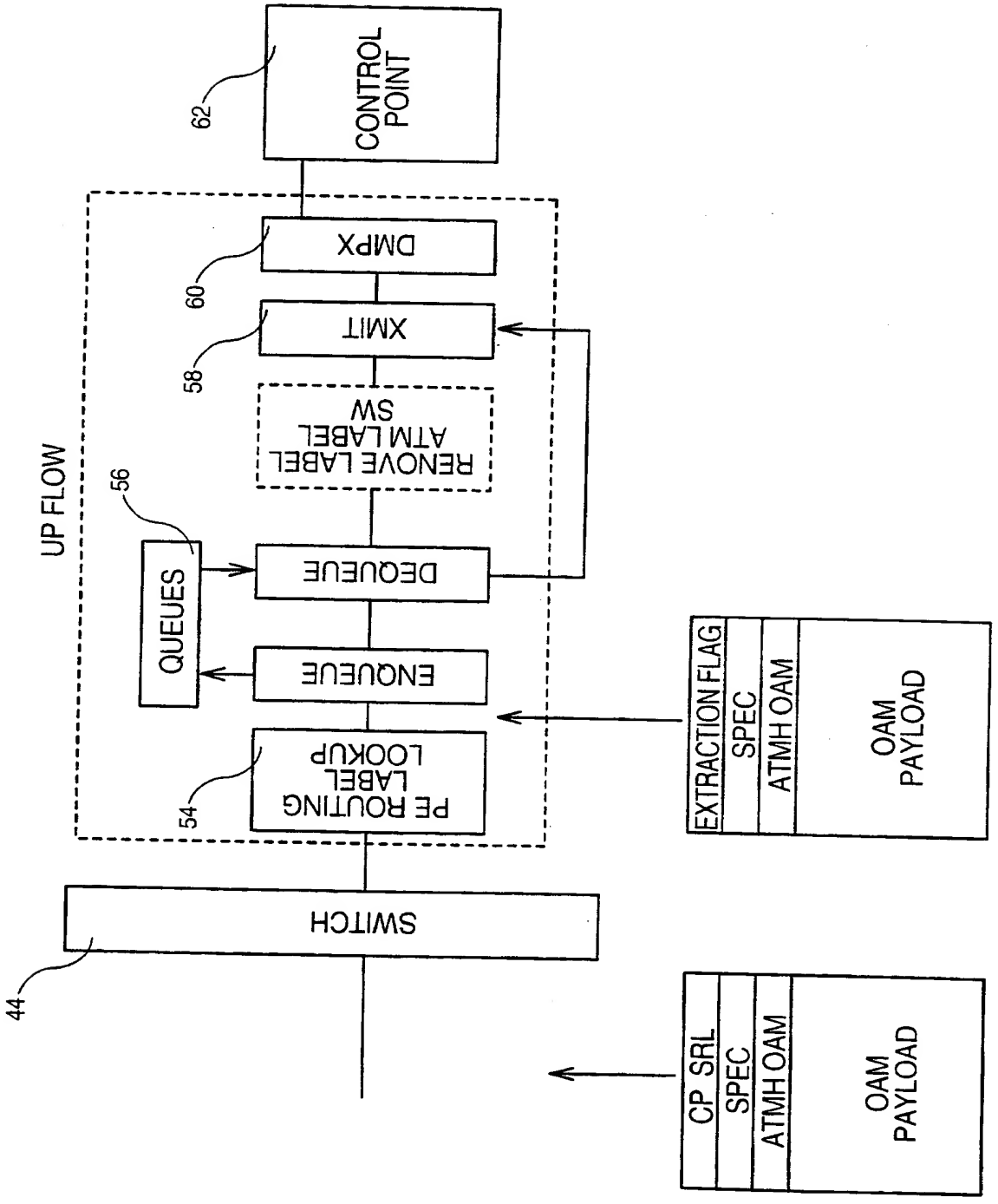
CONTROL POINT
62
DMPX
60
XMIT
58
RENOVE LABEL ATM LABEL SW
UP FLOW
56
QUEUES
DEQUEUE
ENQUEUE
PE ROUTING LABEL LOOKUP
54
EXTRACTION FLAG
SPEC
ATMH OAM
OAM PAYLOAD
SWITCH
44
CP SRL
SPEC
ATMH OAM
OAM PAYLOAD

FIG. 5B

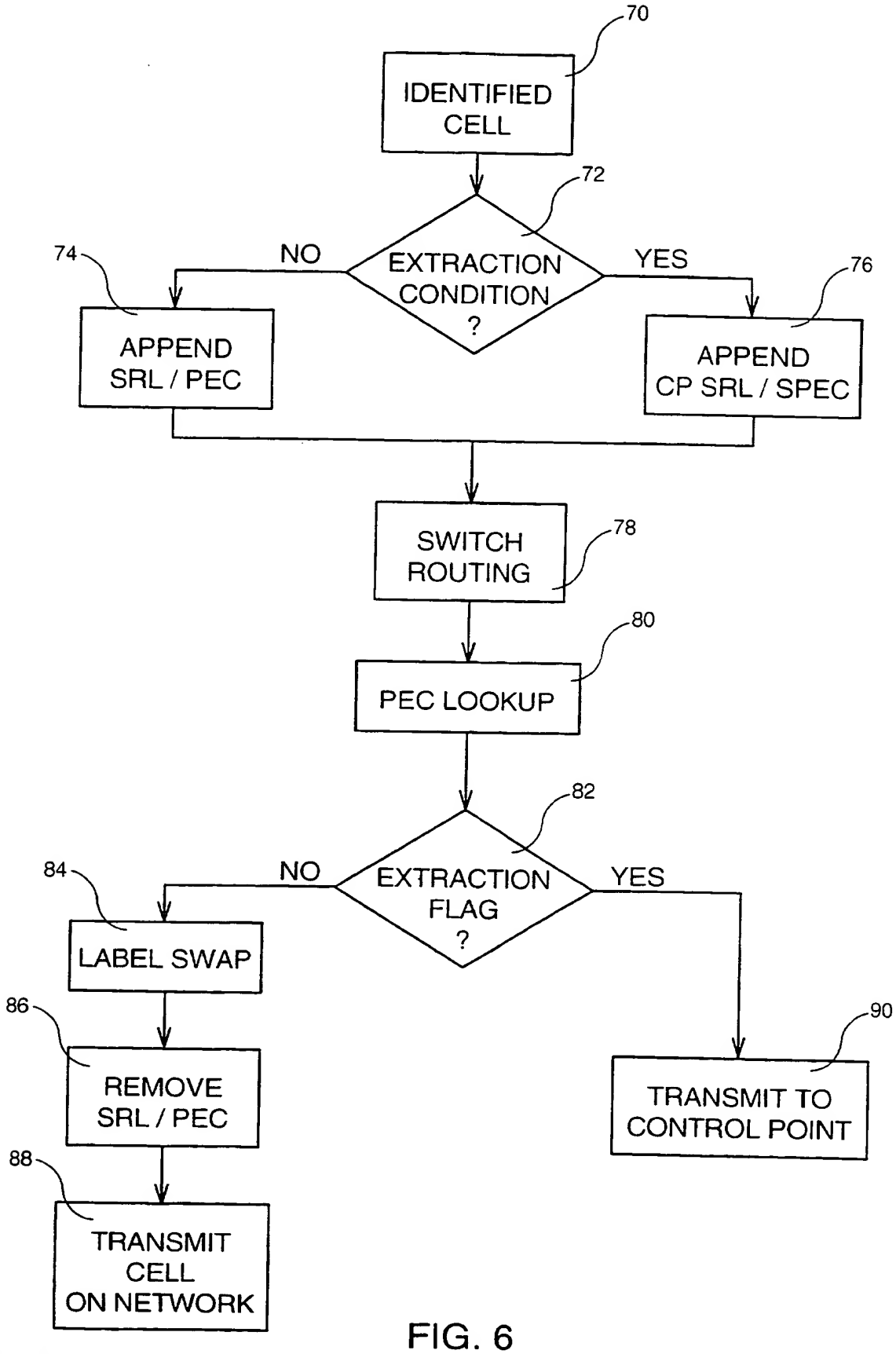
70
IDENTIFIED CELL
72
EXTRACTION CONDITION ?
NO
YES
74
APPEND SRL / PEC
76
APPEND CP SRL / SPEC
SWITCH ROUTING
78
PEC LOOKUP
80
82
EXTRACTION FLAG ?
NO
YES
84
LABEL SWAP
86
REMOVE SRL / PEC
88
TRANSMIT CELL ON NETWORK
90
TRANSMIT TO CONTROL POINT

FIG. 6

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